

# **Juvenile Passage through the Large Locks and Other Things...**

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# Acknowledgements

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Eric Warner**
- **Waterways Experiment Station  
Gene Ploskey**



**SALMON BAY**

Large Lock  
Waiting Pier

Culvert Intake  
Hydroacoustic Transducers  
Strobe Lights

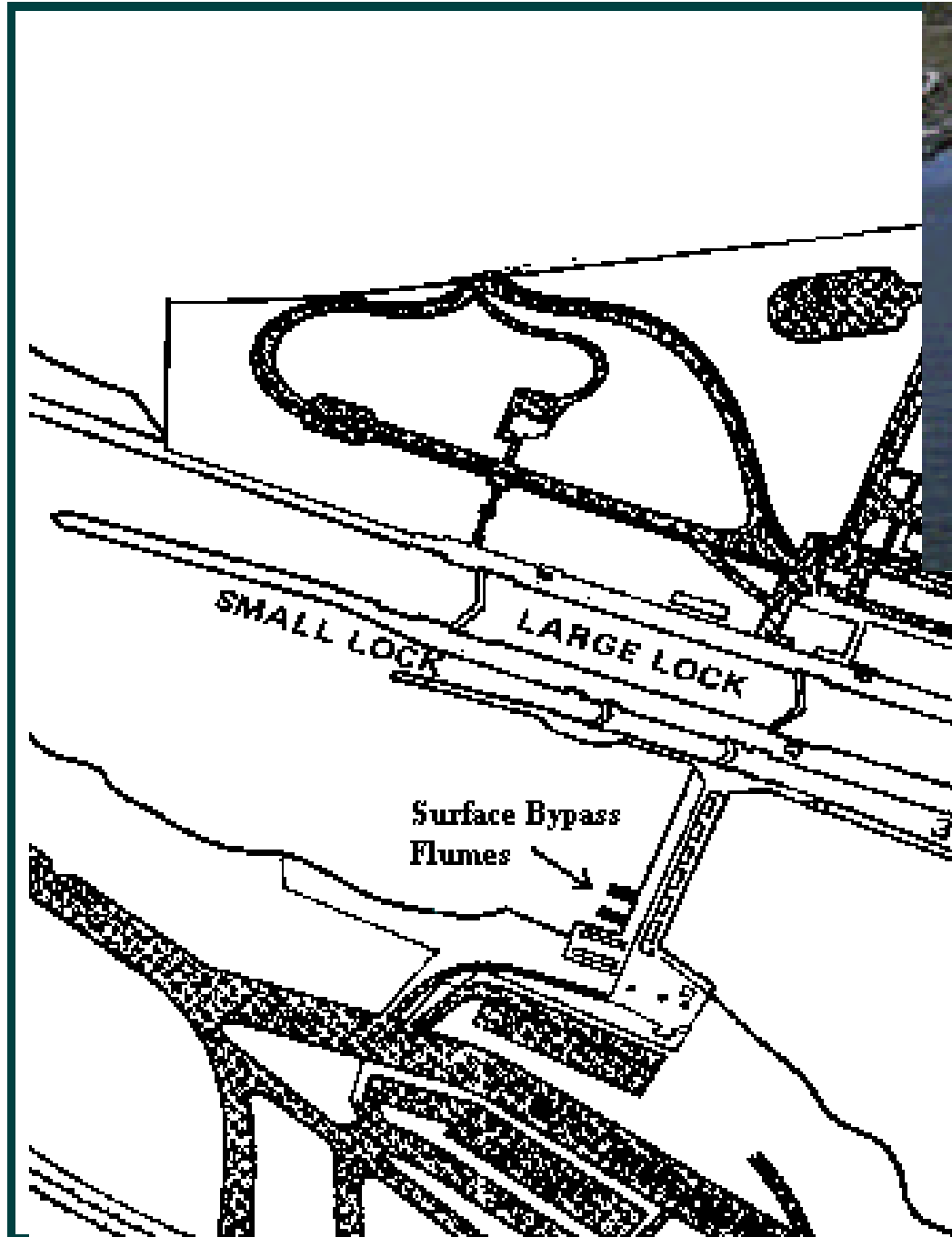
Surface Bypass  
Flumes

SMALL LOCK

LARGE LOCK

80' x 825'

30' x 160'





## **Project Objectives:**

- ◆ **Increase juvenile salmon (smolt) use of the spillway.**
- ◆ **Reduce the entrainment of salmon and steelhead smolts into the filling culverts of the large lock chamber. Field test and evaluate various behavioral guidance techniques.**
- ◆ **If entrainment reduction is not completely successful, reduce the injury and mortality of entrained smolts.**



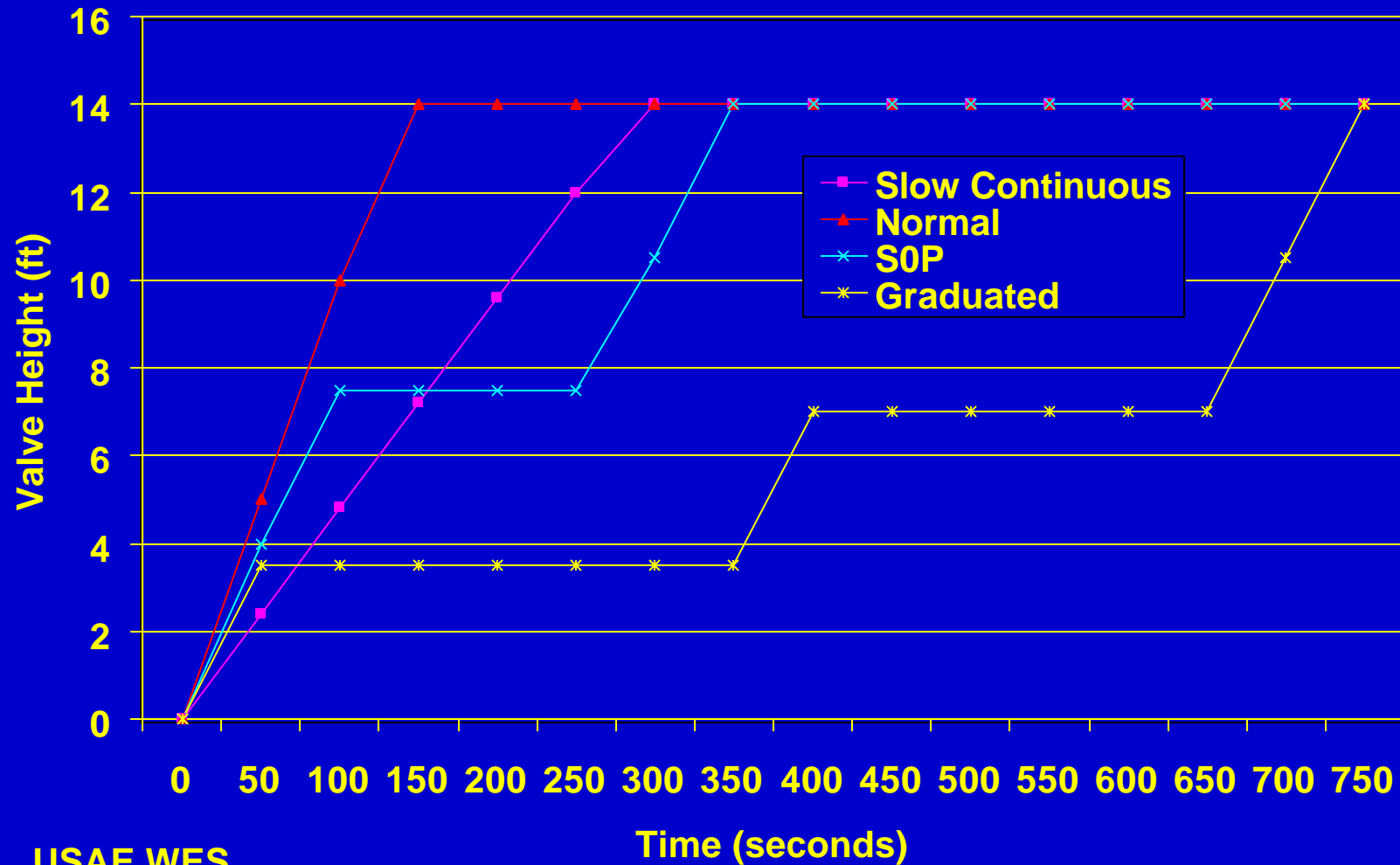
# Flume Monitoring

Observer Counts, Overhead Video Camera



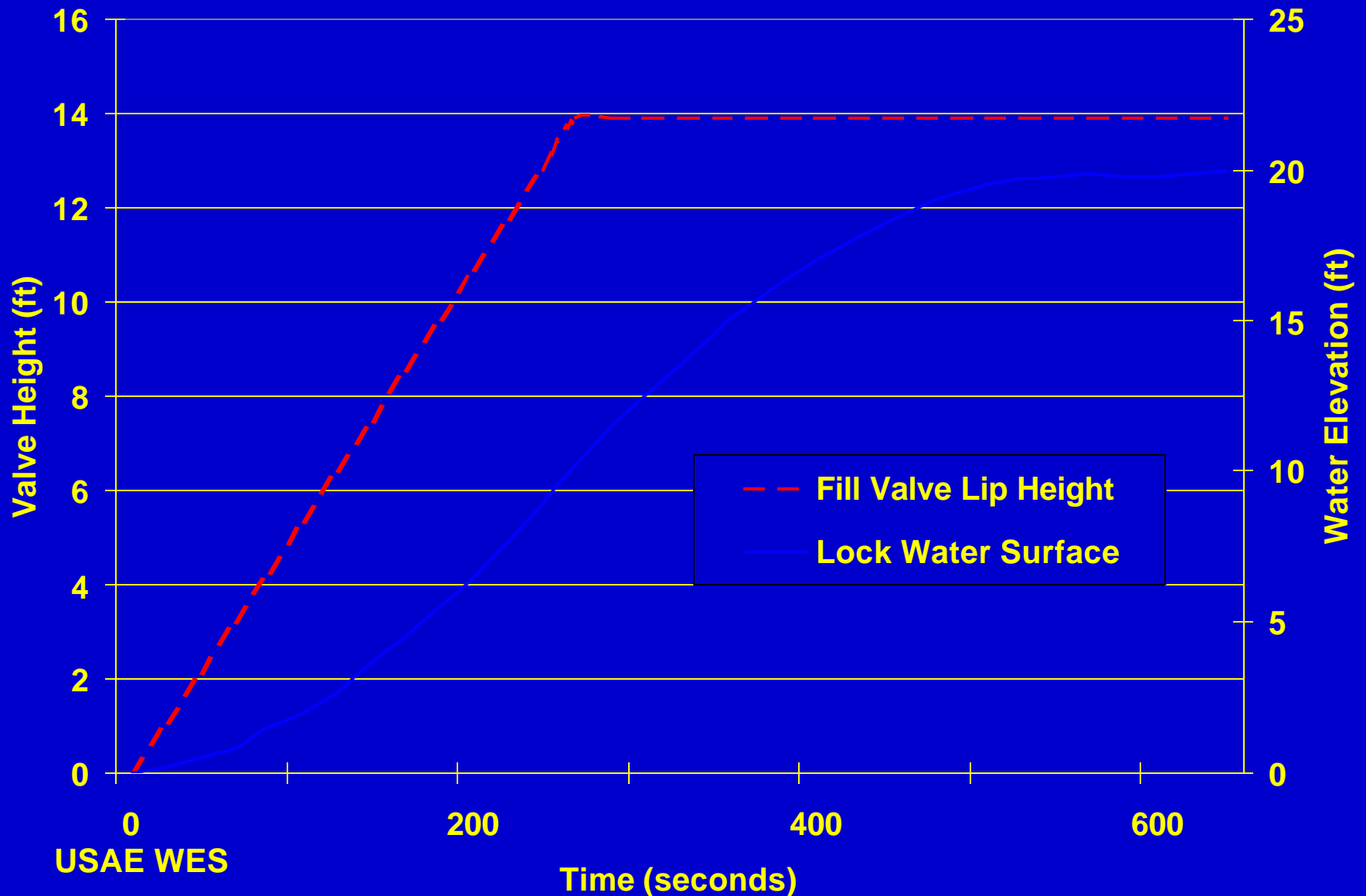
# Entrainment/Injury Monitoring: Different Slow Fill Types

Stoney Gate Valve Travel Time for Four Fill Types



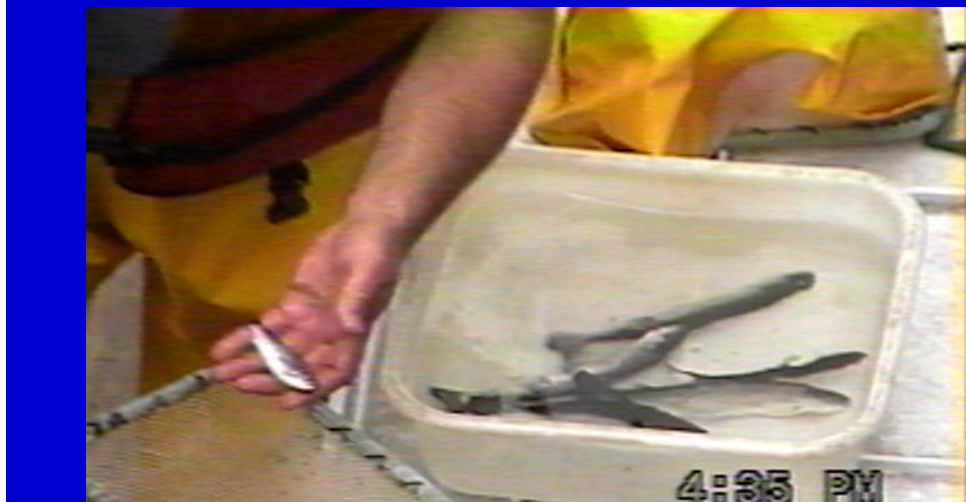
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# Slow Fill: Fill Rate as Water Surface rise in Feet per Minute



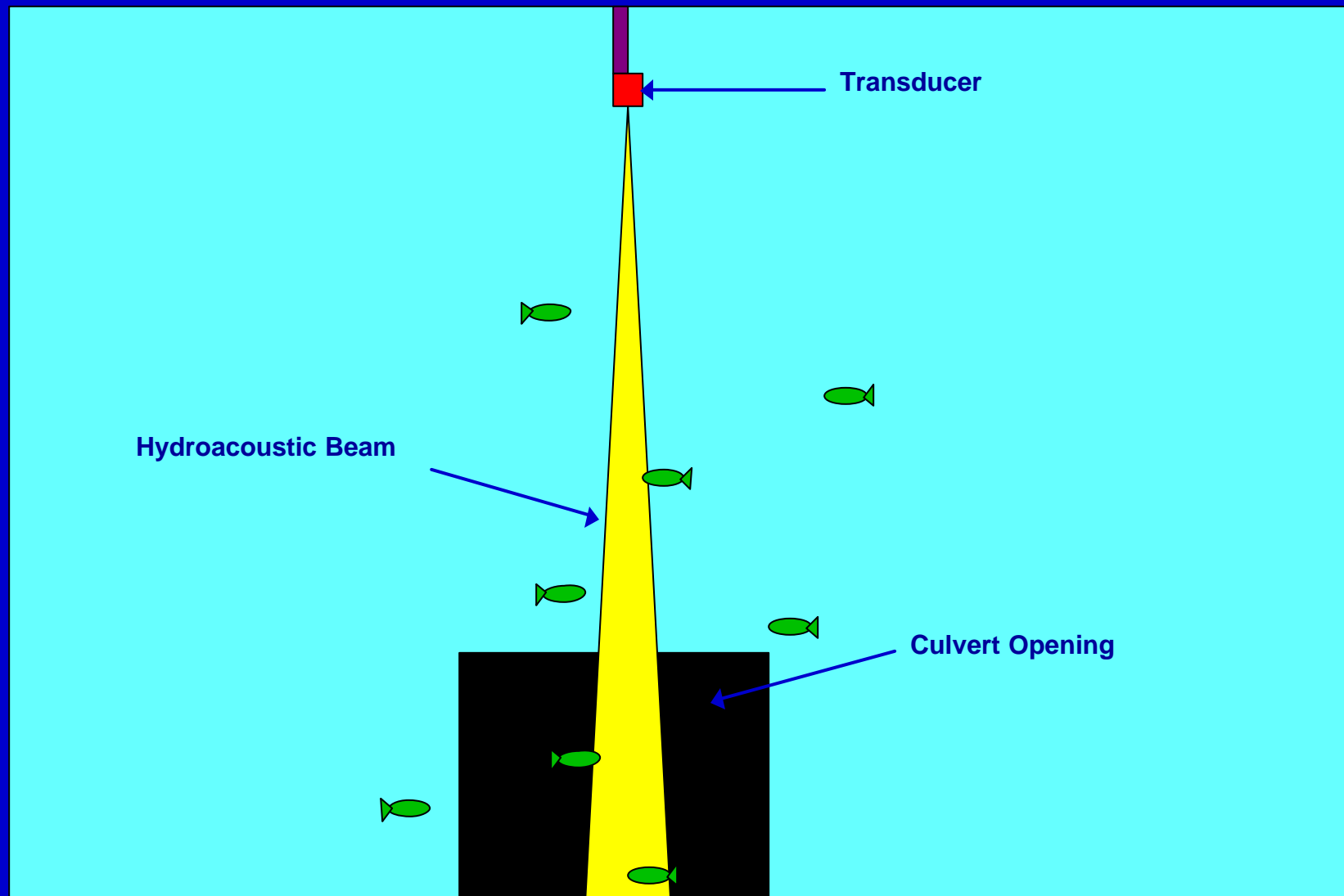


# Entrainment/Injury Monitoring: Purse-seining



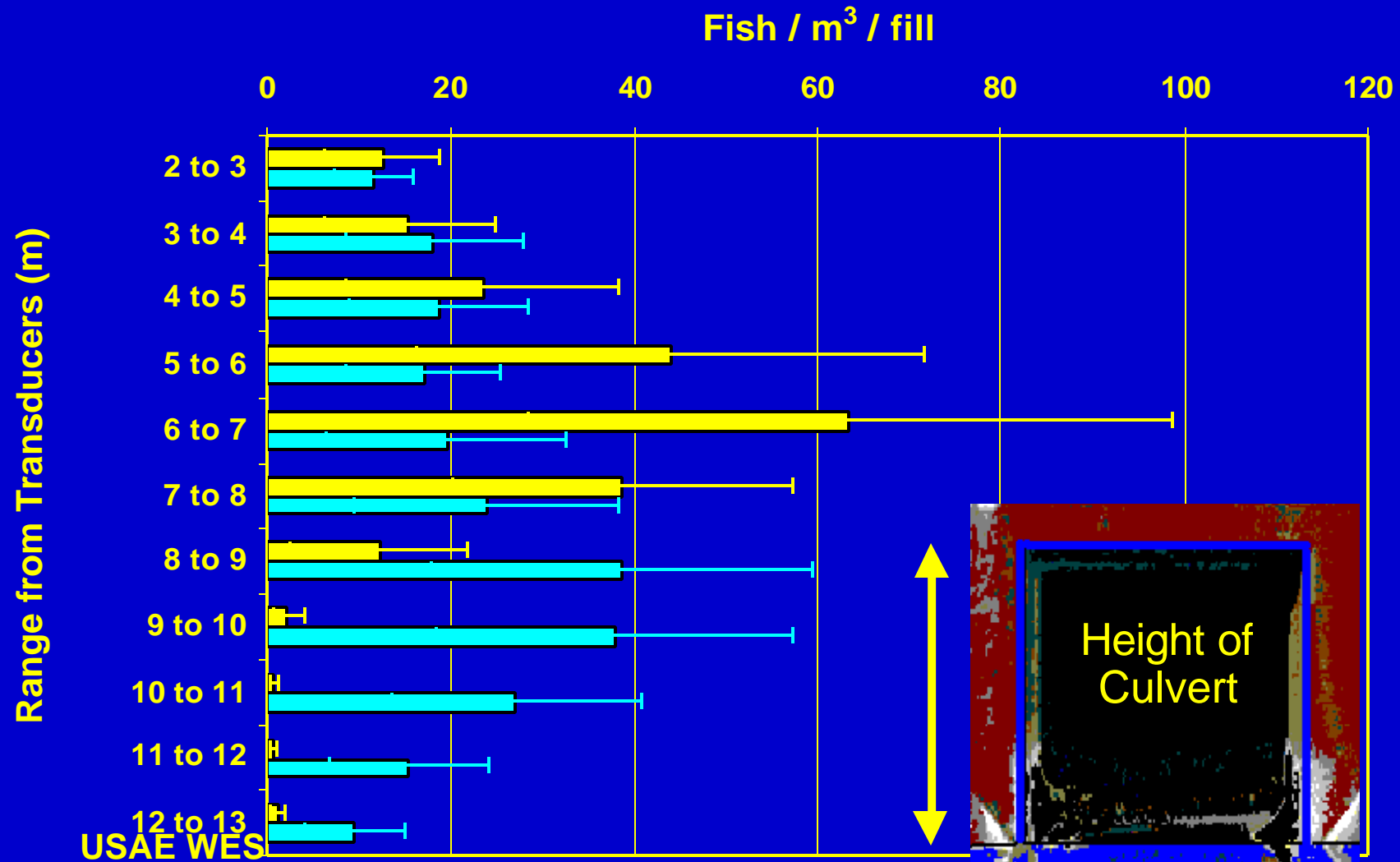


# Hydroacoustic Beam Relative to Culvert Opening



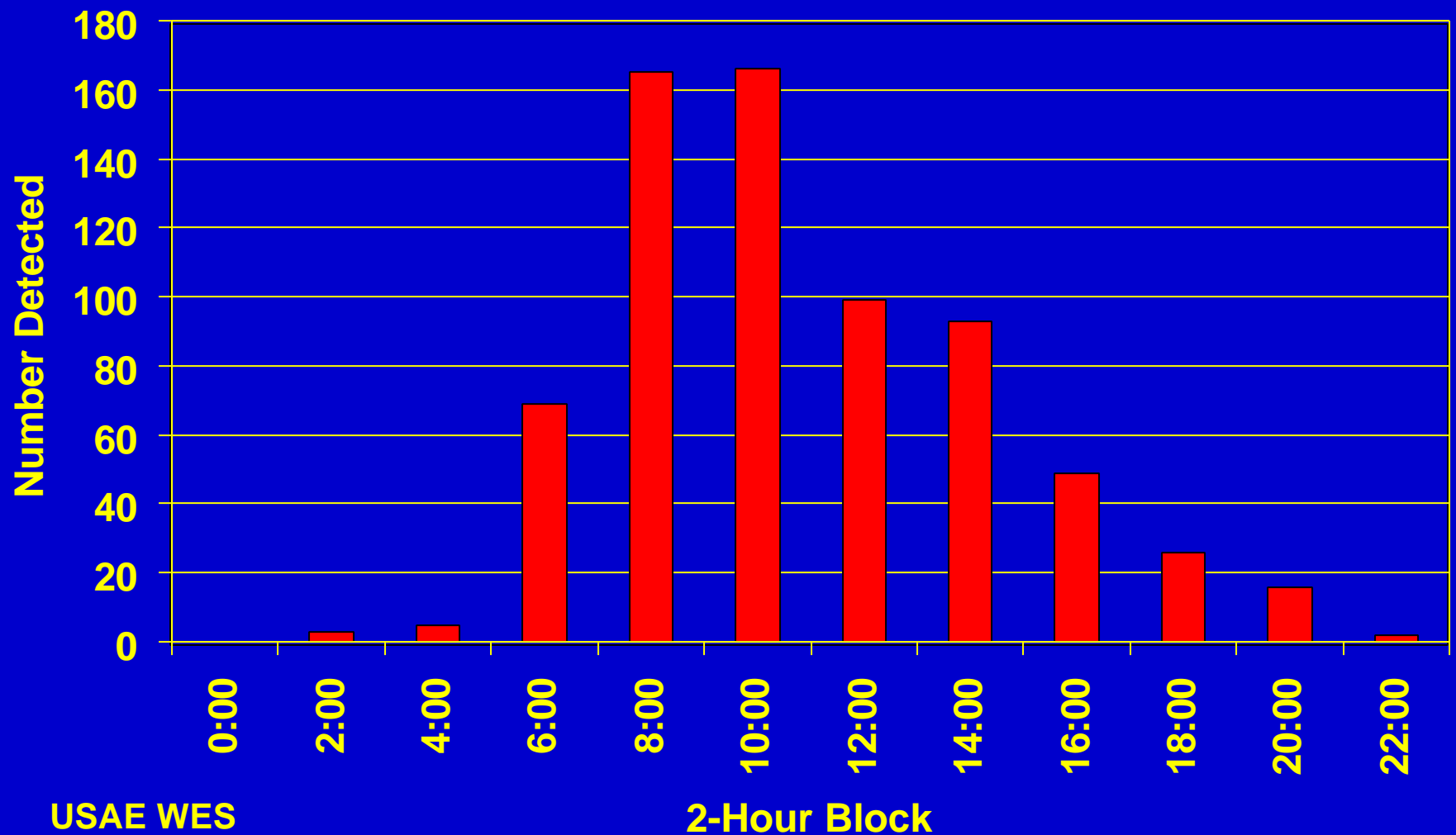
# Strobe Light Results

Mean fish densities among control and test treatments during daytime fill events

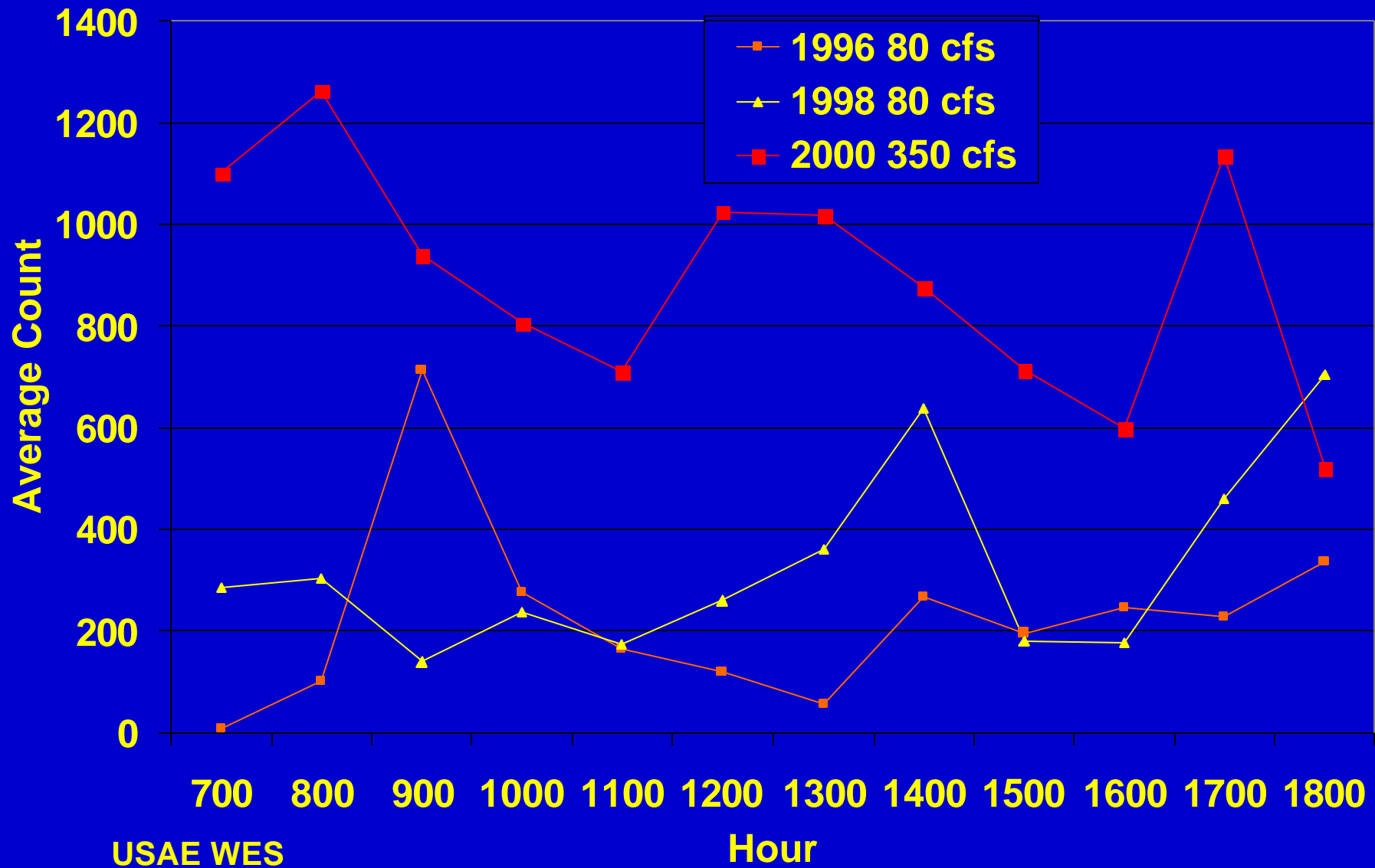


# Flume Count: Diel Passage

PIT-tag Detections by Hour

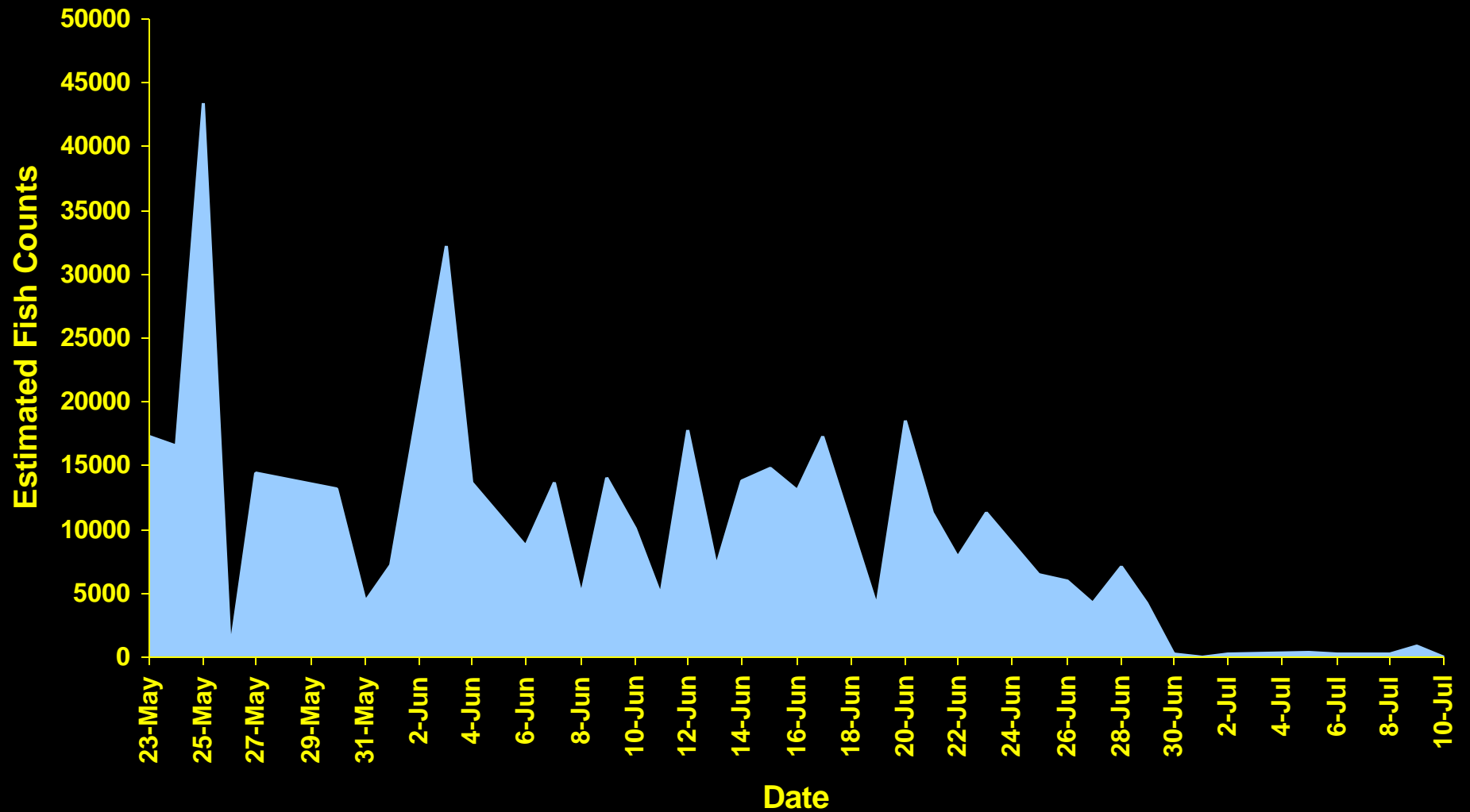


# Mean Hourly Passage for 3-Years



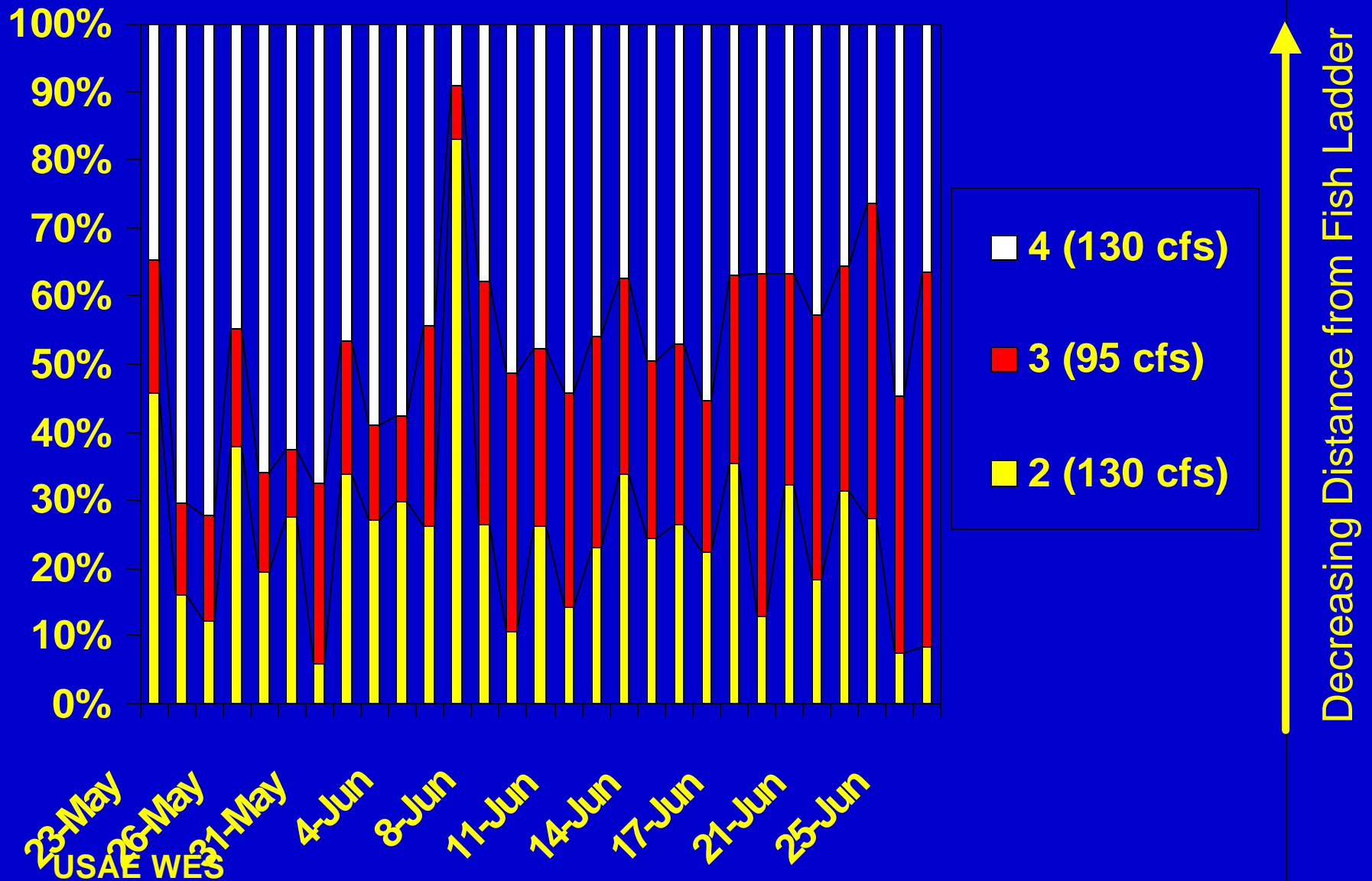
# Daily Counts for 2000

## Estimated Smolt Passage over Flumes Chittenden Locks, 2000

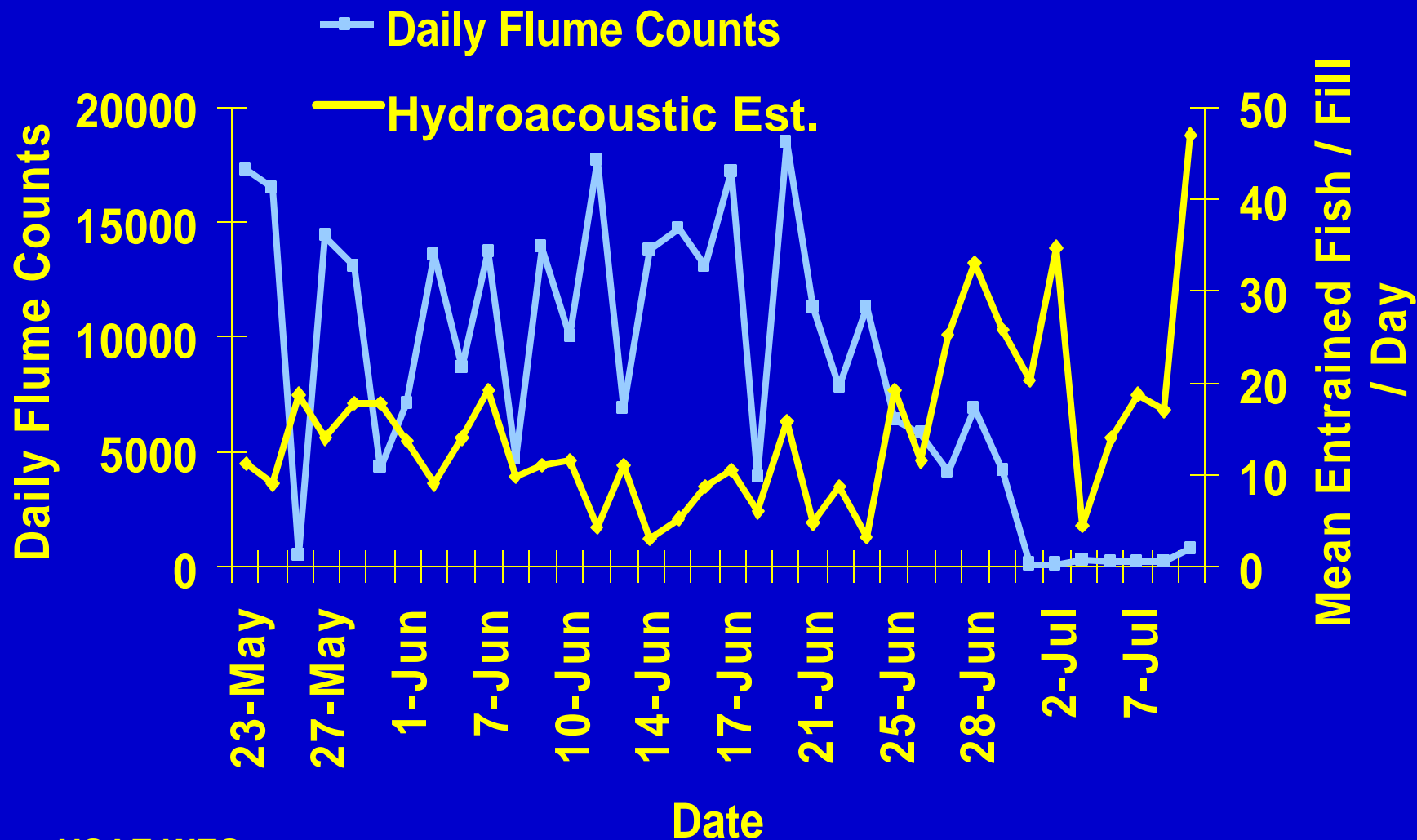




## Results: Proportional Passage by Flume

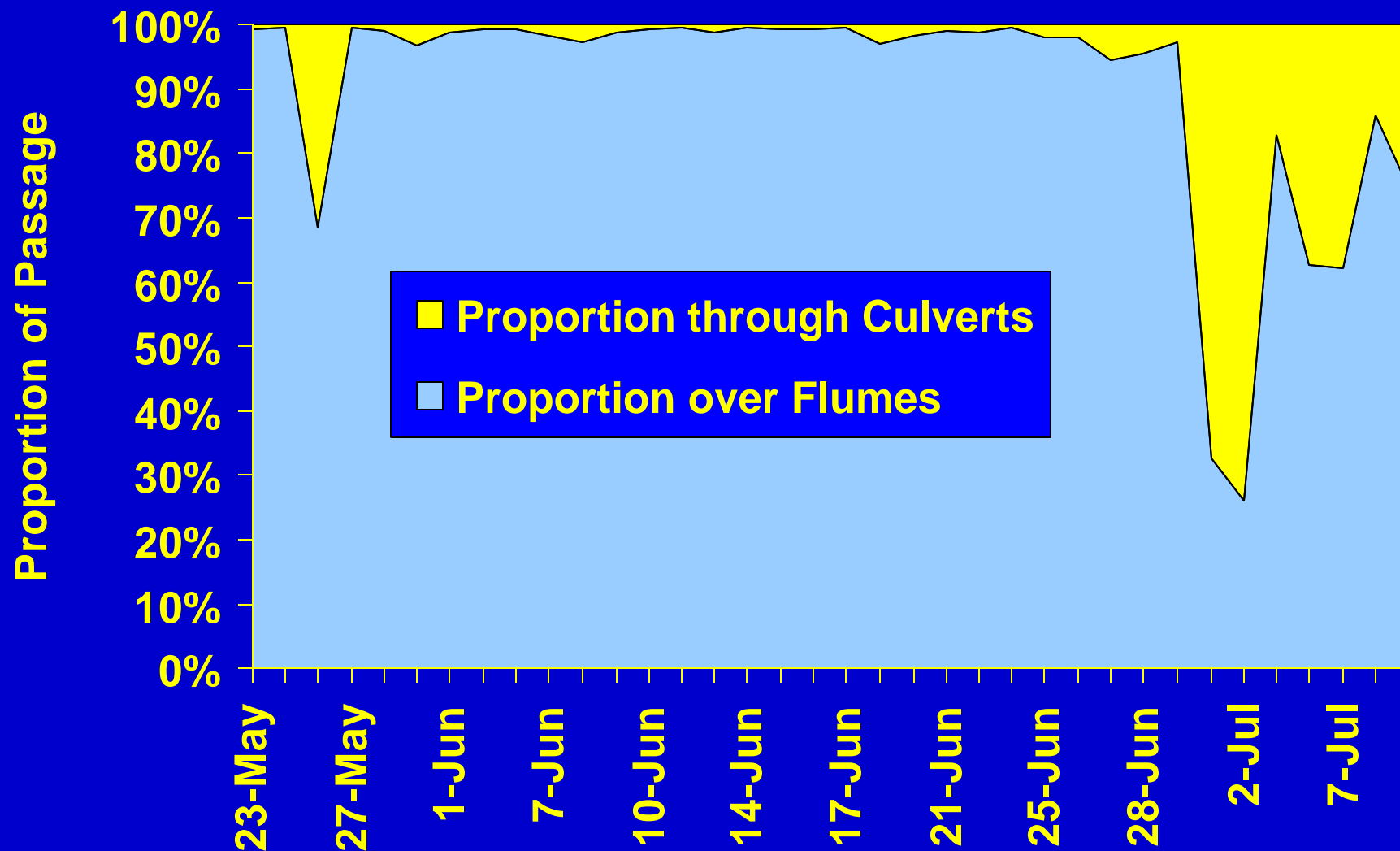


## Proportional Passage: Flume or Culvert Intake (Entrainment) Measured by Hydroacoustics and Flume Counts



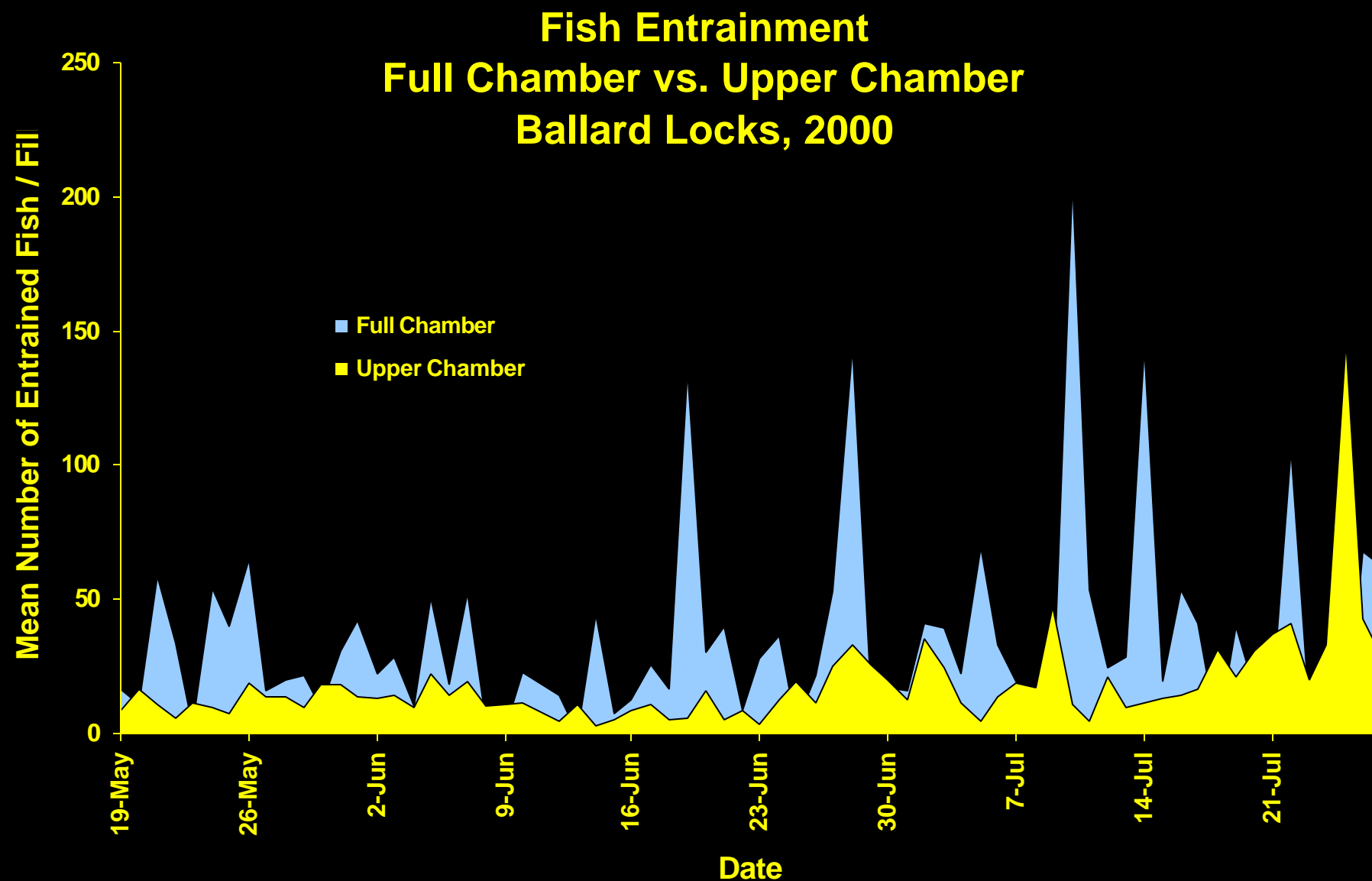
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## Proportional Passage Measured by Hydroacoustics and Flume Counts

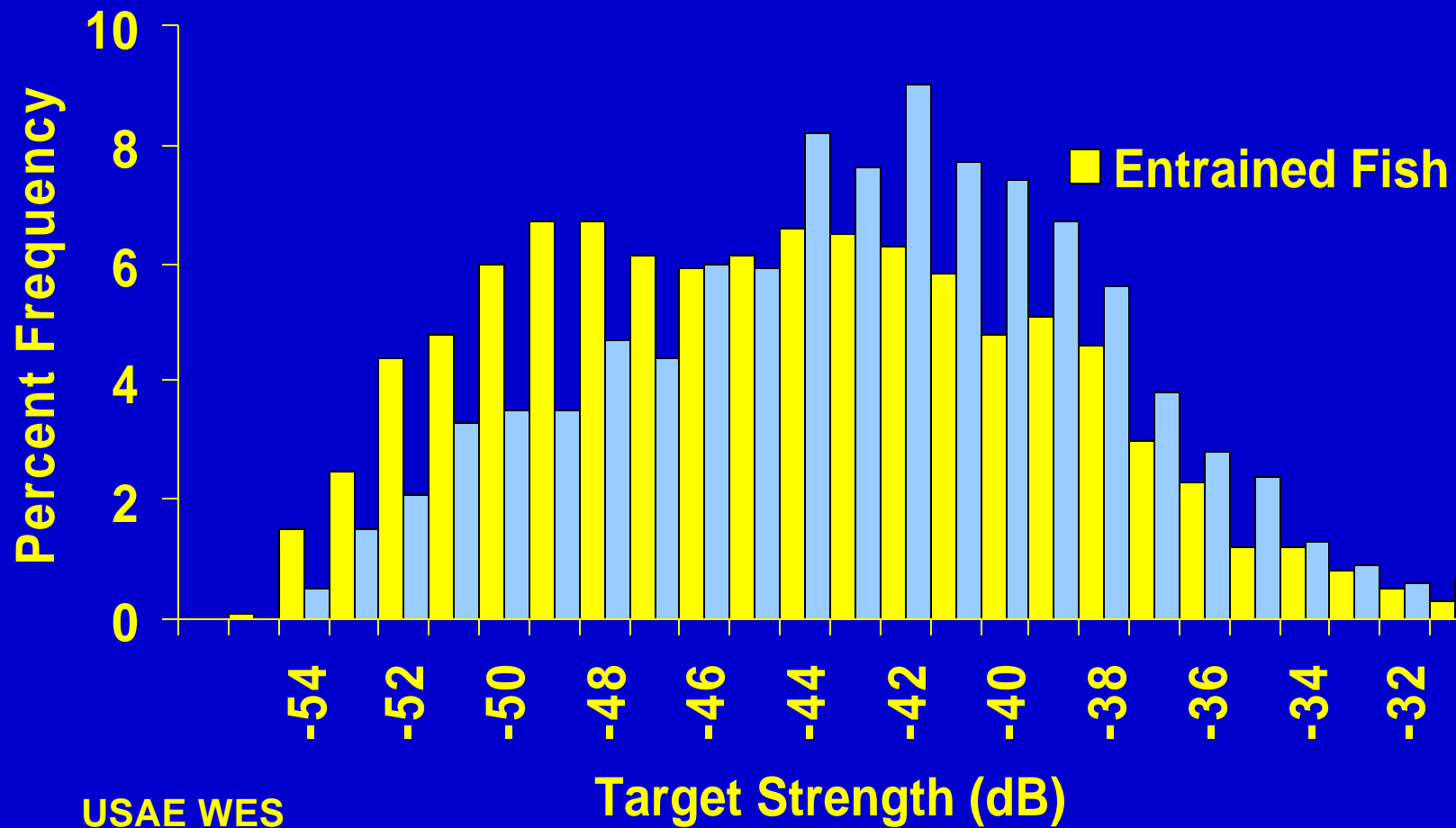


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# Culvert Entrainment Measured by Hydroacoustics

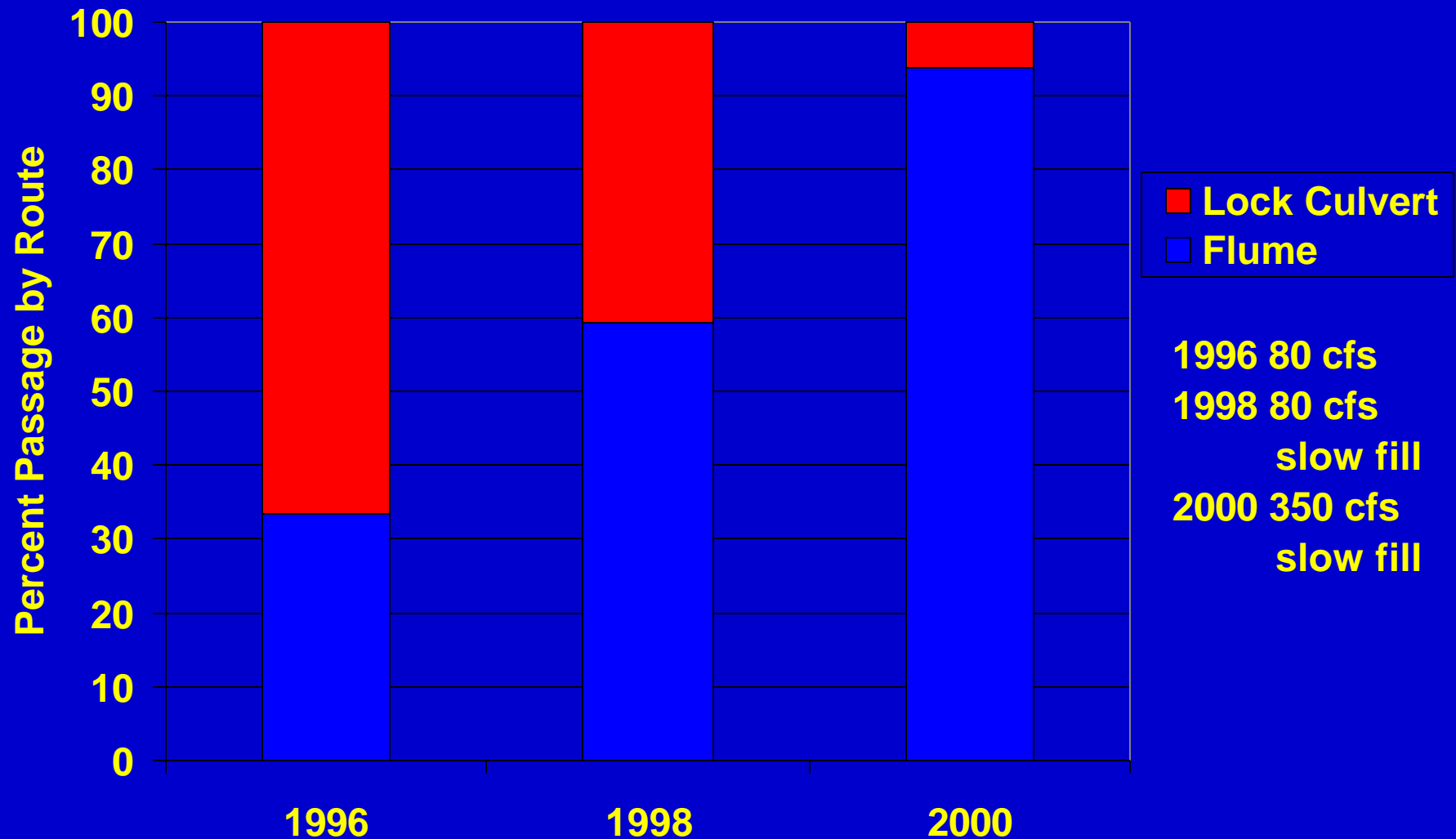


# Target Strength Distribution Entrained vs. Non-entrained Fish Ballard Locks, 2000

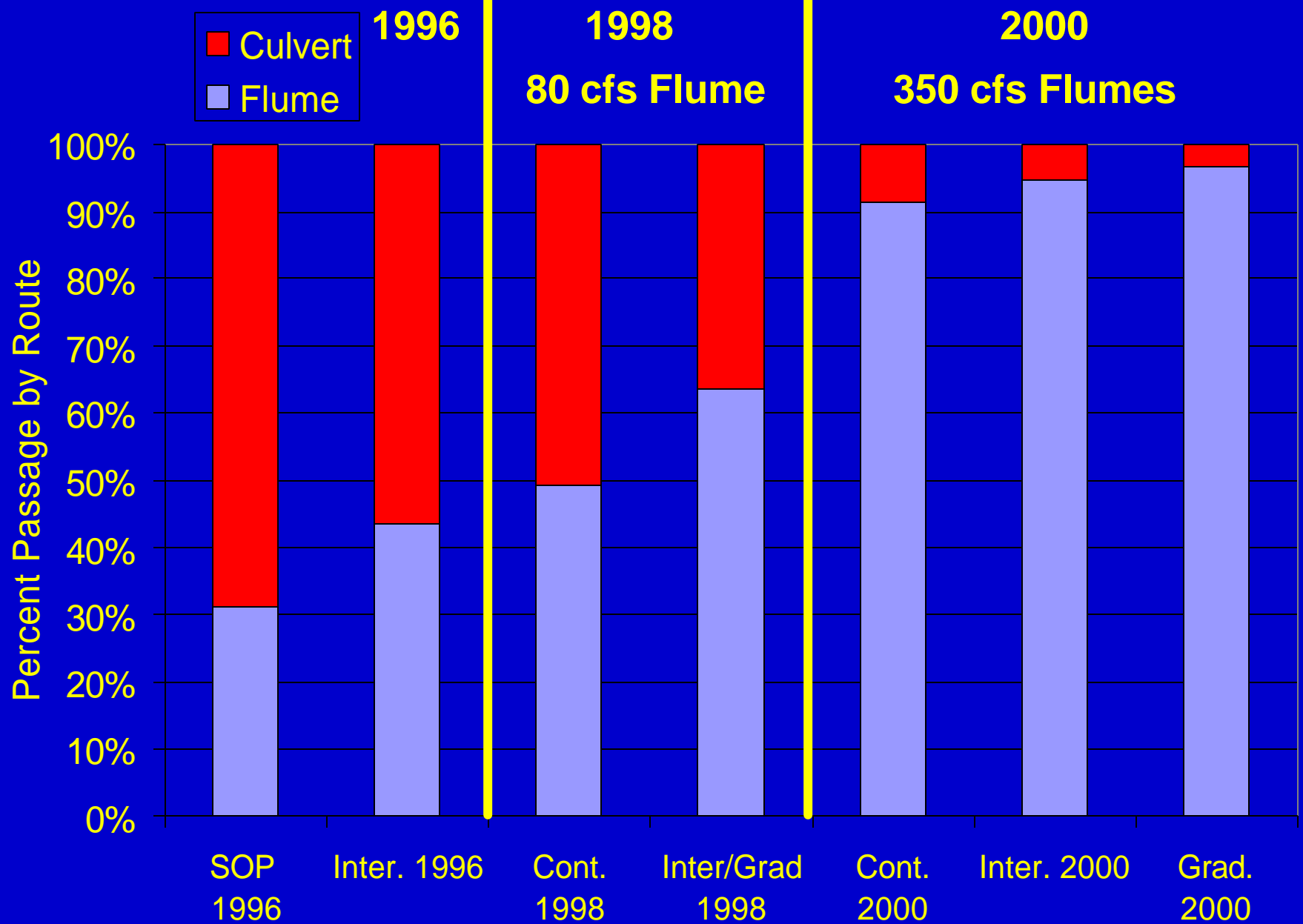




# Proportional Passage: Flume or Culvert Intake (Entrainment) Measured by Purse-seine Catch Estimate and Flume Counts



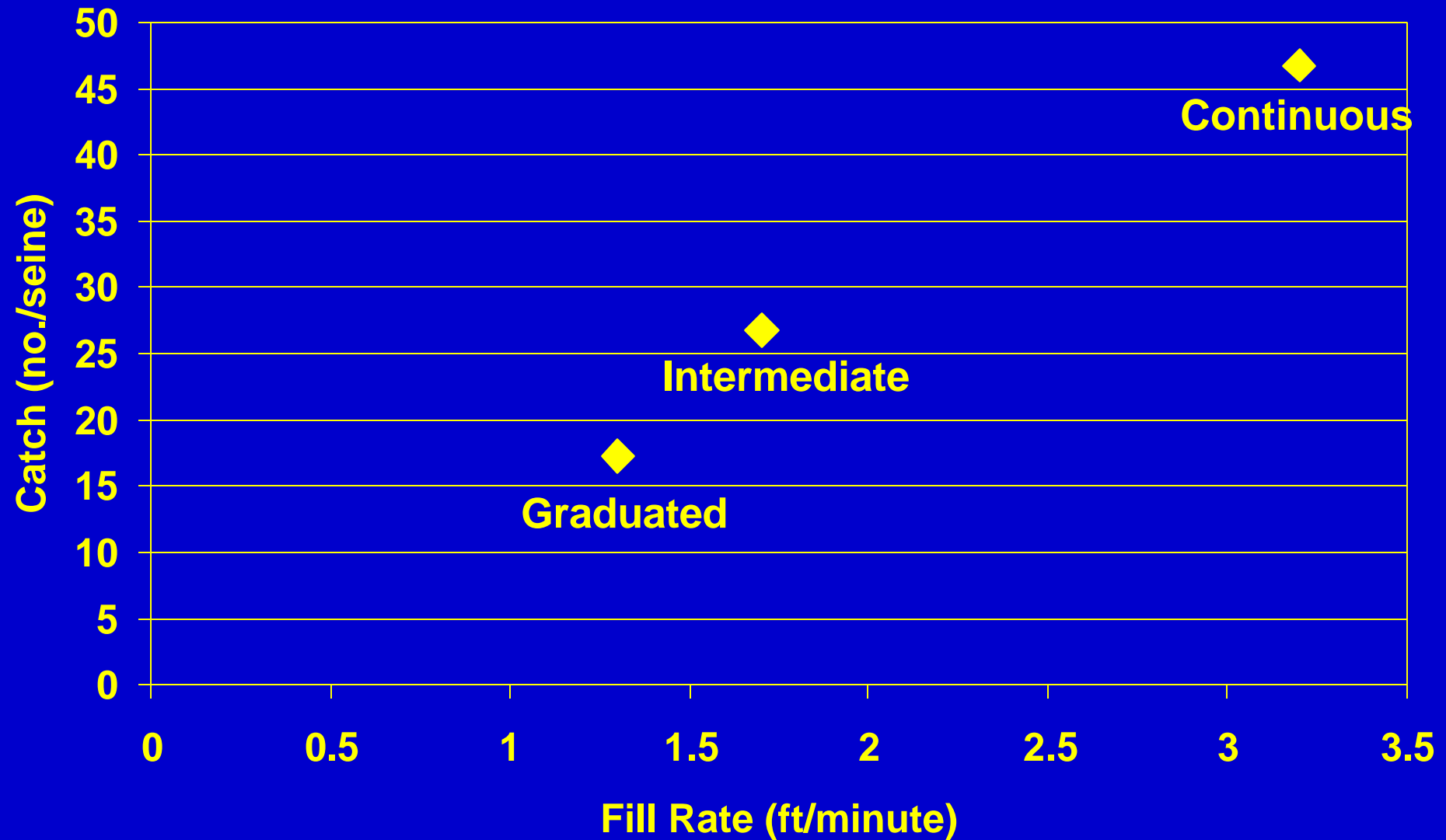
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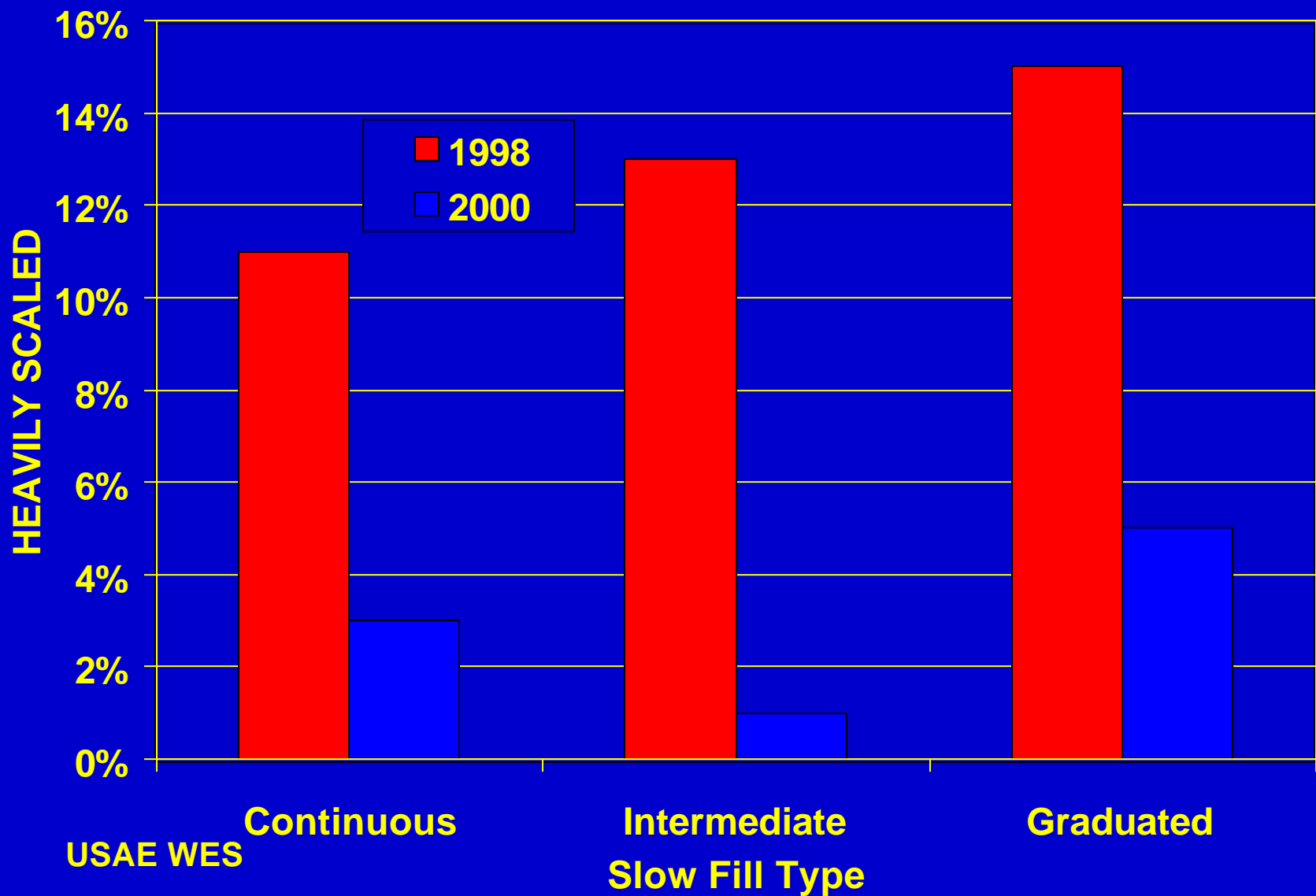
→ **Increasing Fill Time**

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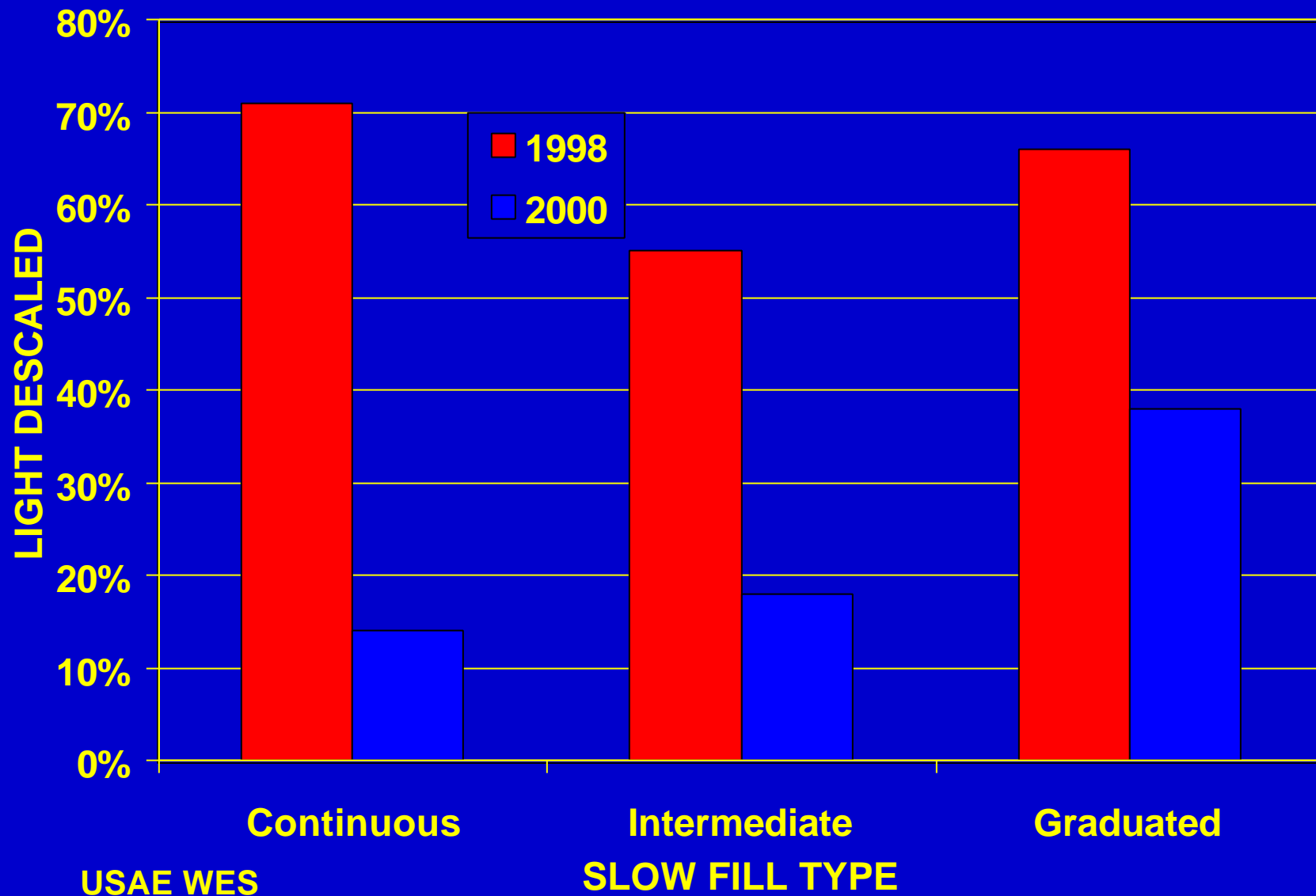
## Comparison of Fill Rate vs Catch Per Unit Effort -- 2000



## Barnacle Removal: Comparison of Heavy Descaling Before (1998) and After (2000)



## Barnacle Removal: Comparison of Light Descaling Before (1998) and After (2000)





## Summary and Conclusions

- Moving fish over the spillway results in the greatest reduction in injury and mortality by reducing passage through the culvert intakes.
- We have seen a sustained increase in the number of fish using the spillway over 3-years of monitoring, 33% 1996; 60% 1998; and 95% 2000.
- In low-flow years slowing the lock fill rate can decrease entrainment from 40-60%.
- Fish that are still entrained exhibited 70-90% less heavy descaling (>10%) since barnacles were removed.
- Preliminary testing of strobe lights shows promising potential to reduce entrainment under low-flow conditions. Evaluation of a full system lay-out will be conducted during 2001.
- King County & Seattle are working with the Corps to find additional feasible sources of water for fish passage – including reducing Lake Washington elevation and increasing saltwater intrusion into the Ship Canal.